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S. W. STRATTON, DIRECTOR

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SPECIFICATIONS FOR MARINE SEXTANTS

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SPECIFICATIONS FOR MARINE SEXTANTS

ABSTRACT

These specifications, incorporating standard practice in design and performance of sextants, are the basis for certificates issued by the Bureau of Standards. They cover the rigidity, durability, convenience of operation, and mechanical perfection of the instrument; range and accuracy of the scales; consistent tolerances for the mirrors, shade glasses, and telescopes; and provisions for adjustment and replacements.

New instruments are expected to conform closely with these specifications or represent improvements. The precision required of old instruments is placed somewhat below that required of new in order that those which are still serviceable and reliable may not be excluded from certification.

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INTRODUCTION

These specifications, incorporating standard practice in design and performance of sextants, have been prepared after extensive conferences with both makers and users of navigation instruments.

Certificates issued by the Bureau of Standards will be based on these specifications.

New instruments for which certificates are desired should conform closely to the specifications. Actual improvements in performance or design are, however, encouraged. In case any instrument differs in any way from the specifications, it must be accompanied by a statement as to exactly in what particulars it differs and why. If its performance tests are at least as good as the standard, a certificate will be issued and the points of differences from the standard type noted on the certificate.

No old sextant will be refused a certificate because of lack of modern improvements, provided the performance tests show it to be serviceable.

Sextants failing to pass the tests will be issued a "Report" instead of a certificate. Such a sextant may still be usable for some purposes by one who knows its deficiencies and how to correct them.

SPECIFICATIONS

I. ASSEMBLED INSTRUMENT

1. **ANGULAR RANGE.**—The sextant must be capable of measuring an angle of 130° .

2. **TOLERANCE.**—The sextant will be examined particularly for errors due to eccentricity of scale, errors of graduation of scale, faulty index and horizon mirrors, and faulty shade glasses. For new instruments, the maximum error due to all causes not including graduation shall not exceed $40''$. For old instruments, however, which are otherwise good, an error of $90''$ will be allowed.

3. **WEIGHT.**—The weight of the sextant without a telescope shall not exceed $3\frac{1}{2}$ pounds.

II. PARTS

1. **FRAME.**—(1) *Construction.*—The frame should be constructed of hard bronze, finished in a lusterless, durable, dark color. The three legs for support shall be placed, two at the outer extremities of the outer radial arms, the third below the pivot of the index arm. The angle between the line of sight of the telescope and the perpendicular to the horizon glass shall not exceed 13° .

(2) *Pivot system.*—The pivot shall be conical in form and ground to a true and accurate fit to its bearings. It must terminate in a shouldered square on which shall be fitted a deep-bearing washer, held in place by a set screw. There must be free motion but no end play.

(3) *Index Arm.*—The index arm shall be rigid enough so that it will not be bent under service conditions.

(4) *Clamp*.—A suitable clamp and slow motion should be provided for making the final setting of the index arm.

(5) *Grip*.—The grip of the instrument should be of well-seasoned hardwood of suitable shape and dimensions, and the supports for the grip long enough to give at least 1 inch between it and the frame.

2. *ARC SCALE*.—(1) *Graduated Arc*.—The graduated arc shall be upon silver, divided to 10', the graduation to extend from a negative reading of 5° to a positive reading of at least 145°.

(2) *Graduation Marks*.—The graduation marks shall be straight, clean-cut, distinct, colored in black, and shall be identical in character with those of the vernier; the marks in both cases shall be narrow enough to prevent adjacent marks on the vernier from overlapping marks on the scale to such an extent as to confuse the reading. The marks shall begin on the side next the vernier or at a uniform distance not greater than 0.01 inch from the edge, and shall be in length as follows: The 5° marks, 0.20 inch; the 1° marks, 0.14 inch; the 30' marks, 0.10 inch; the 10' marks, 0.06 inch, or in approximately those proportions, so that the scale may be easily read. The numbering shall be at every 5 degrees.

(3) *Uniformity of Scale*.—The vernier scale shall subtend within 10'' the same main scale reading at all parts of the latter.

3. *VERNIER*.—(1) *Marks*.—The marks on the vernier shall begin uniformly at the edge nearest the scale and shall be in length as follows: The 5' marks, 0.20 inch; the 1' marks, 0.14 inch; the 20'' mark, 0.10 inch, or in approximately those proportions. The divisions of the vernier shall be graduated for a least count of 20''. At least two additional scale divisions should be placed at each end of the vernier.

(2) *Reading Glass*.—The reading glass should be a flat field lens of about 1 inch equivalent focal length, attached in such a way as to be convenient for reading the scale. The hinge shall allow play enough to focus the glass over the full length of the vernier. A diffusing screen should be provided to shade the vernier.

4. *MIRRORS*.—(1) *Accuracy and Dimensions*.—The mirrors shall have plane faces flat to less than one-half wave length of sodium light, and the angle between the two faces shall not exceed 4''. The index mirror should be 0.14 inch thick, the remaining dimensions to be 1.32 by 1.77 inches; the horizon mirror 0.14 inch thick and 1.13 by 0.88 inch, and the silvered part shall be 0.56 inch wide. These dimensions should be followed sufficiently closely to permit

all mirrors of each type to be interchangeable from one holder to another.

(2) *Mounting*.—The mounting of the mirrors shall be such as to allow suitable adjustments for parallelism and for perpendicularity to the plane of the instrument without straining the mirrors.

5. SHADES.—(1) *Number and density*.—Colored shade glasses, four in number and of different densities, shall be fitted for the index mirror, and three similar ones for the horizon mirror. The combination of the four shades for the index mirror shall be of density sufficient to reduce the intensity of the rays of the sun so that the observer may observe the sun with comfort and accuracy.

(2) *Error*.—The shade glasses, singly or in combination, must not cause an error in angular measurements in excess of 20''.

6. TELESCOPES.—(1) *Adjustment*.—The telescope mounting shall be adjustable so as to bring the line of sight into approximate parallelism with the plane of the arc. An adjustment should be provided for moving the telescope in a direction perpendicular to the plane of the circle. Approximately one-half the beam of light entering the telescope should be from each part of the horizon mirror.

(2) *Lens System*.—One plain tube and two telescopes shall be provided. The object glass of the long telescope is to have a focal length of at least $5\frac{1}{3}$ inches, and a clear aperture of at least $\frac{7}{8}$ inch. Two eyepieces shall be supplied for the long telescope, and these shall be of such focal length and separations as to produce magnifying powers of about 6 and 10 diameters, respectively. The eye tubes are to be fitted with a fine wire through the center of the field, and with two coarse wires at right angles to it, parallel to each other, 32' apart, and at equal distances from the center. The adapter for the diaphragm in each tube shall extend to the end of the draw tube to permit of its being easily adjusted in the focus of the eyepiece. The short telescope shall be of the Galilean type of a magnifying power of about 3 diameters, and a clear aperture of at least $\frac{7}{8}$ inch.

(3) *Quality of Lenses*.—All the lenses are to be of first quality, made from first-class stock, accurately ground, polished, and centered. The outer lens of the object glass must be composed of a glass not easily corroded by weather. The lenses shall be mounted in brass cells and be readily removable. All lenses shall be fitted in their cells free from strain.

(4) *Tubes*.—The plain and telescope tubes shall be made of the best hard-drawn brass as light as practicable, be finished on the outside in a durable lusterless dark color, and fit into the collar by continuous or interrupted screw threads. The castings used for fitting the parts together and for mounting the lenses should be of hard brass, free from imperfections.

(5) *Definition*.—The definition of each telescope shall be such that the product of the limit of resolution in seconds by the magnification shall be not more than 60. The lines of the resolution chart used for this test shall be well illuminated and of good contrast. The magnifying power shall be within 0.3 of that stated by the manufacturer.

7. CASE AND EQUIPMENT.—(1) *Case*.—The sextant case should be of hard wood, durably constructed, and capable of being securely fastened.

(2) *Boxing*.—The instrument is to stand on its legs in the box and is to be held in its position by chocks on the bottom of the box touching only the grip and its supports and allowing a slight movement. It is to be held down in the box by a block fastened to the lid and just touching the top of the grip as it lies in the chocks. The chocks, blocks, and brackets for securing the instrument and accessories must be well secured and the bearing surfaces covered with felt. The box should be only large enough to take the instrument without touching it except as herein provided.

(3) *Auxiliaries*.—Besides the necessary tools for adjustment (screw drivers, keys, etc.), the case shall contain the following accessories securely stowed: Two neutral-tinted sunshades, of different intensities, to screw on telescope eyepiece; 1 spare index mirror; and 1 spare horizon mirror. The screw drivers shall be made of best bar steel, one to be forged to a point to fit the slot in the head of the large screws, another to fit the small screws, and each to be oil tempered. They shall be fitted with neat handles of tough wood about 4 inches long and with ferrules.

TEST FEES

SCHEDULE 46.—OPTICAL INSTRUMENTS

The original Schedule 46 was published in Circular of the Bureau of Standards, No. 27, December, 1910. The new item of fee for testing sextants is now added. The items in the original schedule relate to tests other than sextants.

(5) Sextants. For testing and issuing a certificate or report on sextant in accordance with the tests described in Circular 110, Bureau of Standards. \$5

REGULATIONS

1. REMITTANCES.—Fees may be remitted by money orders or check drawn to the order of the "Bureau of Standards." Delays in forwarding fees will involve corresponding delays in the completion of the tests, as the articles can not be returned until all fees due thereon have been received.

2. IDENTIFICATION MARKS.—Instruments and the packages in which they are shipped should both be plainly marked to facilitate identification.

3. SHIPPING DIRECTIONS.—Instruments should be securely packed in cases or packages which may be used in returning them to the owner. Transportation charges are payable by the party desiring the test, and should be prepaid. Unless otherwise arranged, articles will be returned by express, "collect."

4. BREAKAGE.—Since all possible care is taken in testing and packing, the Bureau can not assume any responsibility for breakage or other damage to instruments submitted for test.

5. ADDRESS.—Packages should be addressed simply, "Bureau of Standards, Attention Division IV-4, Department of Commerce, Washington, D. C."

WASHINGTON, September 20, 1920.



